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New records of *Puccinia* species on *Poaceae* from Fairy Meadows, PakistanN.S. AFSHAN^{1*}, A.N. KHALID² & A.R. NIAZI²¹*Centre for Undergraduate Studies & ²Department of Botany,
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ABSTRACT — During a survey of rust fungi of Fairy Meadows, *Puccinia brachypodii* var. *major* on *Poa attenuata* and *P. substriata* var. *indica* on *Pennisetum orientale* were reported for the first time. These new rust fungi records bring to 70 the number of *Puccinia* species reported on *Poaceae* from Pakistan. *Puccinia brachypodii* var. *poae-nemoralis* and *P. poarum* are also reported for the first time from Fairy Meadows.

KEY WORDS — *Anthoxanthum odoratum*, graminicolous rust, Hunza

Introduction

This paper continues our study of graminicolous rust fungi from Pakistan. Previously, about 100 species of graminicolous rust fungi including 68 taxa of *Puccinia* have been reported from Pakistan (Afshan et al. 2010, 2011a,b). During a 2007 survey of the rust flora of Fairy Meadows, four members of *Poaceae* infected with rust fungi were collected. Among these, *Puccinia brachypodii* var. *major* on *Poa attenuata* and *P. substriata* var. *indica* on *Pennisetum orientale* represent new records for Pakistan, while *P. brachypodii* var. *poae-nemoralis* on *Anthoxanthum odoratum* and *P. poarum* on *Poa pratensis* are additions to the rust flora of Fairy Meadows. *Anthoxanthum odoratum* represents a new host for rust fungi from Pakistan.

Materials & methods

Freehand sections of infected tissue and spores were mounted in lactophenol and gently heated to boiling. The preparations were observed under a NIKON YS 100 microscope. Drawings of spores and paraphyses were made using a Camera Lucida (Ernst Leitz Wetzlar, Germany). Spores were measured using an ocular micrometer. At least 25 measurements per fungal structure were taken. Both light microscope and scanning electron microscope (SEM) images were obtained of the spores. Collections

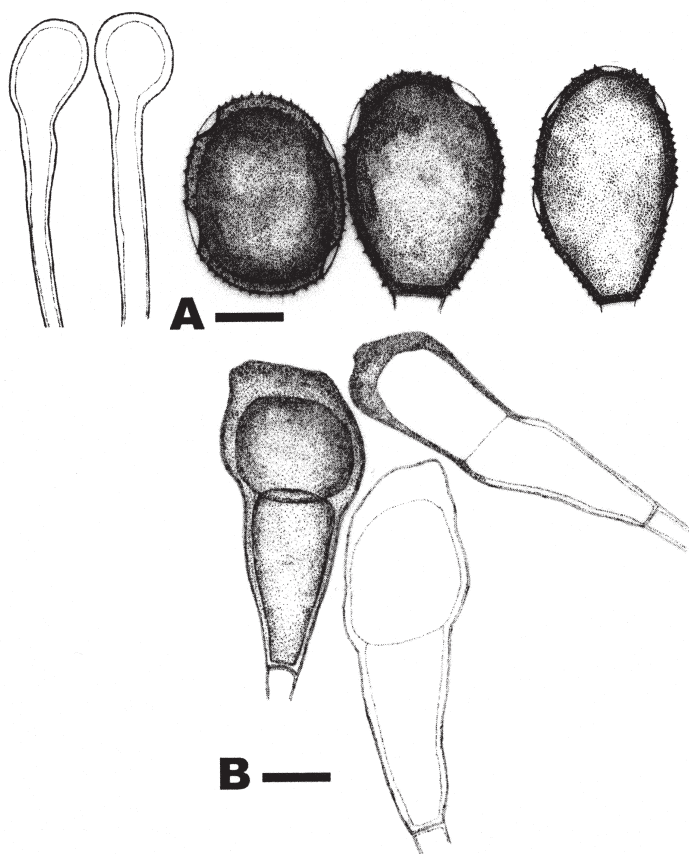
have been deposited in the herbarium of the Botany Department, at the University of the Punjab, Lahore (LAH).

Enumeration of taxa

Puccinia brachypodii var. *major* Cummins & H.C. Greene, Mycologia 58: 711 (1966)

FIGS A-B

SPERMOGONIA and AECIA unknown. UREDINIA amphigenous, subepidermal, light brown, 0.6–0.8 × 1.9–2.0 mm. UREDINIOSPORES globose to subglobose or obovoid, (16–)21–24(–29) × (23–)27–35(–39) µm (mean 22 × 30 µm); wall 1.5–2 µm thick, light yellow to pale brown, echinulate; germ pores (6–)



FIGS. A–B: *Puccinia brachypodii* var. *major*.
A: Urediniospores and paraphyses. B: Teliospores. Scale bars = 10 µm.

8–11, scattered, obscure; pedicel hyaline, 6–8 μm wide and 32–50 μm long. PARAPHYSES 70–95 μm long, hyaline to pale yellow, capitate, head 15–17 μm wide; wall ≥ 2 μm thick. TELIA amphigenous, sub-epidermal, loculate, with stromatic paraphyses, dark brown, $0.4\text{--}0.7 \times 0.6\text{--}0.8$ mm. TELIOSPORES 1–2 celled, oblong to clavate, golden brown to chestnut brown but paler basally, smooth; $20\text{--}26 \times (27\text{--})39\text{--}43(55)$ μm (mean 26×34 μm); wall 1.5–2 μm thick; apex truncate or rounded, sometimes conical, 3–5 μm thick; germ pore 1 per cell, obscure; pedicel short, hyaline, $6\text{--}10 \times 31\text{--}45$ μm .

MATERIAL EXAMINED: PAKISTAN, NORTHERN AREAS, Fairy Meadows, at 3036 m a.s.l., stages II + III, on *Poa attenuata* Trin., 12th August, 2007, NSA # 52. (LAH NSA1034).

COMMENTS: *Puccinia brachypodii* var. *major* is a new record for Pakistan, and *Poa attenuata* is a new host record for this fungus. Previously this rust has been reported on *Poa horridula* and *P. candamoana* from Peru (Cummins 1971).

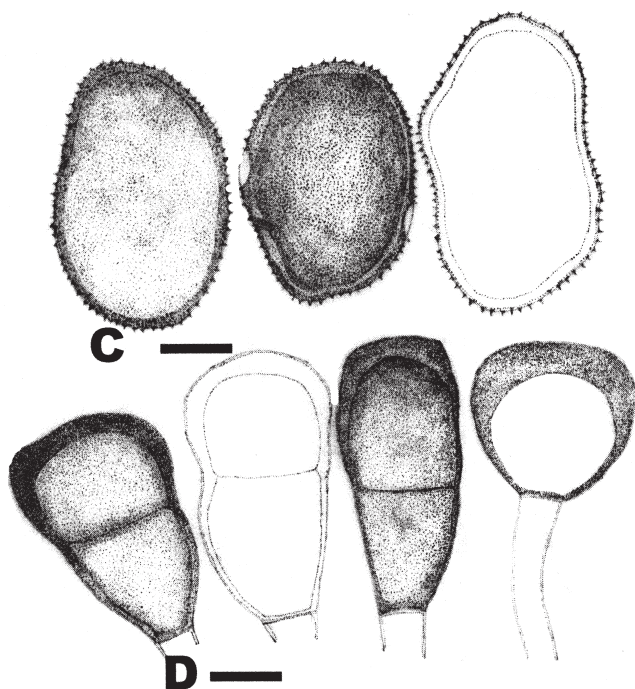
In Pakistan, *Puccinia brachypodii* var. *brachypodii* has been reported on *Brachypodium* sp. from KPK and Kaghan Valley (Kakishima et al. 1993b); and *P. brachypodii* var. *poae-nemoralis* on *Agrostis munroana*, *Poa nemoralis*, *P. pratensis*, and *P. sterilis* from Kaghan Valley, Sharan, Swat, and Azad Jammu & Kashmir (Ahmad 1956a; Kakishima et al. 1993a,b; Masood et al. 1995).

Puccinia substriata var. *indica* Ramachar & Cummins, Mycopath. Mycol. appl. 25: 30 (1965) FIGS C–D

SPERMOGONIA and AECIA unknown. UREDINIA amphigenous, sub-epidermal, yellowish-brown to golden-brown, $0.09\text{--}0.1 \times 0.1\text{--}2.0$ mm. UREDINIOSPORES variable in shape, globose to subglobose or ovoid to ellipsoid, $18\text{--}24(29) \times 21\text{--}24(30)$ μm , pale brown to golden brown, echinulate; wall 1–1.5 μm thick; germ pores 3–4(–5), equatorials; pedicel hyaline, 4–5 μm wide and ≥ 15 μm long. TELIA amphigenous, mostly adaxial, sub-epidermal, erumpent, dark brown to blackish brown, $0.09\text{--}0.5 \times 0.2\text{--}0.6$ mm. TELIOSPORES 1–2-celled, oblong to clavate, $17\text{--}24(29) \times (29\text{--})34\text{--}52(60)$ μm , cinnamon brown to golden brown, paler basally, smooth; wall 2–3 μm thick; apex mostly truncate, sometimes rounded, 4–9 μm thick; germ pores obscure; pedicel hyaline to light brown, $6\text{--}8 \times 8\text{--}12$ μm .

MATERIAL EXAMINED: PAKISTAN, NORTHERN AREAS, Fairy Meadows, at 3036 m a.s.l., stages II + III, on *Pennisetum orientale* Rich., 12th August, 2007, NSA # 70. (LAH NSA1095).

COMMENTS: *Puccinia substriata* var. *indica* is a new record for Pakistan. The variety has been reported from India on *Pennisetum typhoides* (Cummins 1971), and Afshan et al. (2008) reported another variety, *P. substriata* var. *insolita* (on *Panicum antidotale*) from Munchinabad in Pakistan. *Puccinia penniseti-lanati* (on *P. lanatum*) and *Uromyces penniseti* (on *P. americanum* from Kaghan Valley, Tandojam, and Karachi are two other poaceous rusts known to occur



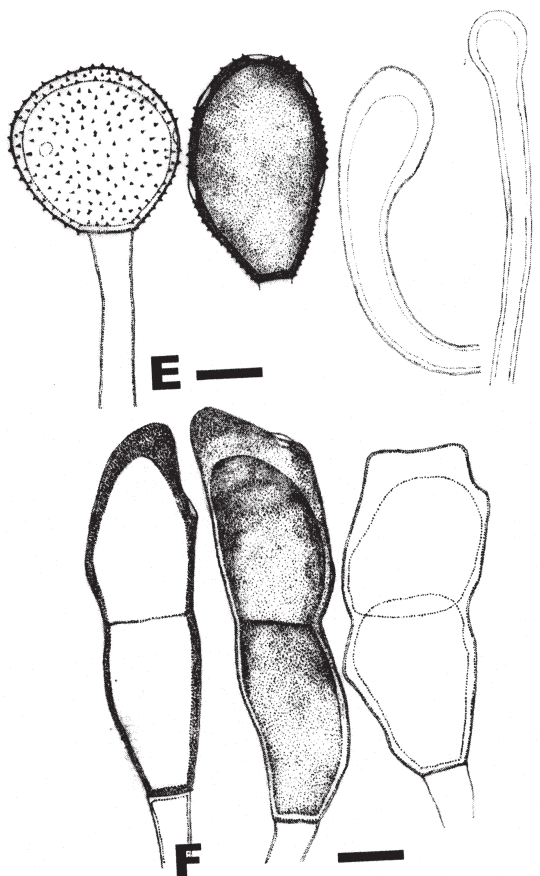
FIGS. C-D: *Puccinia substriata* var. *indica*.

C: Urediniospores. D: 1-2-celled teliospores. Scale bars = 10 μ m.

on *Pennisetum* species in Pakistan (Ahmad 1969; Hasnain et al. 1959; Khan & Kamal 1968).

Puccinia brachypodii var. *poae-nemoralis* (G.H. Otth) Cummins & H.C. Greene,
Mycologia 58: 705 (1966) FIGS E-F

SPERMOGONIA and AECIA unknown. UREDINIA on leaves, mostly adaxial, yellowish or yellowish brown, 0.09–0.2 $\times$ 0.2–0.4 mm. UREDINIOSPORES obovoid or ellipsoid to broadly ellipsoid, 19–26 $\times$ 23–36 μ m (23.2 $\times$ 28.6 μ m); wall 2–3 μ m thick, light brown to cinnamon brown, closely echinulate; germ pores 5–9, obscure; pedicel hyaline, short, 7–8 $\times$ 38–45 μ m. PARAPHYSES cylindric to capitate, hyaline or yellowish, mostly 80–100 μ m long and 14–18 μ m wide, usually geniculata, wall 2–4 μ m thick throughout or to 6 μ m thick in the head. TELIA on leaves, mostly abaxial, sub-epidermal, 0.06–0.1 $\times$ 0.1–0.2 mm, blackish, loculate with a few brown paraphyses surrounding the sori. TELIOSPORES 1–2 celled (few one-celled spores also observed), oblong to clavate, 13–24 $\times$ 40–59(–65) μ m (mean 17.7 $\times$ 50.6 μ m), not or slightly constricted at



FIGS. E–F: *Puccinia brachypodii* var. *poae-nemoralis*.
E: Urediniospores and paraphyses. F: Teliospores. Scale bars = 10 μ m.

the septum; wall 1–1.5 μ m thick, smooth, brown to chestnut brown or paler basally; apex 5–9 μ m thick, truncate or conical; germ pore 1 per cell, upper sub-apical, lower at the equator or near the septum; pedicel short, light brown, 5–6 $\times$ 9–15 μ m, not collapsing, thick walled.

MATERIAL EXAMINED: PAKISTAN, NORTHERN AREAS, Karimabad, Hunza, at 2438 m a.s.l., stages II + III, on *Anthoxanthum odoratum* L., 13th August, 2007; Fairy Meadows, at 3036 m a.s.l., 12th August, 2007, NSA # Gr 58 (G06). (LAH NSA1035a & 1035b).

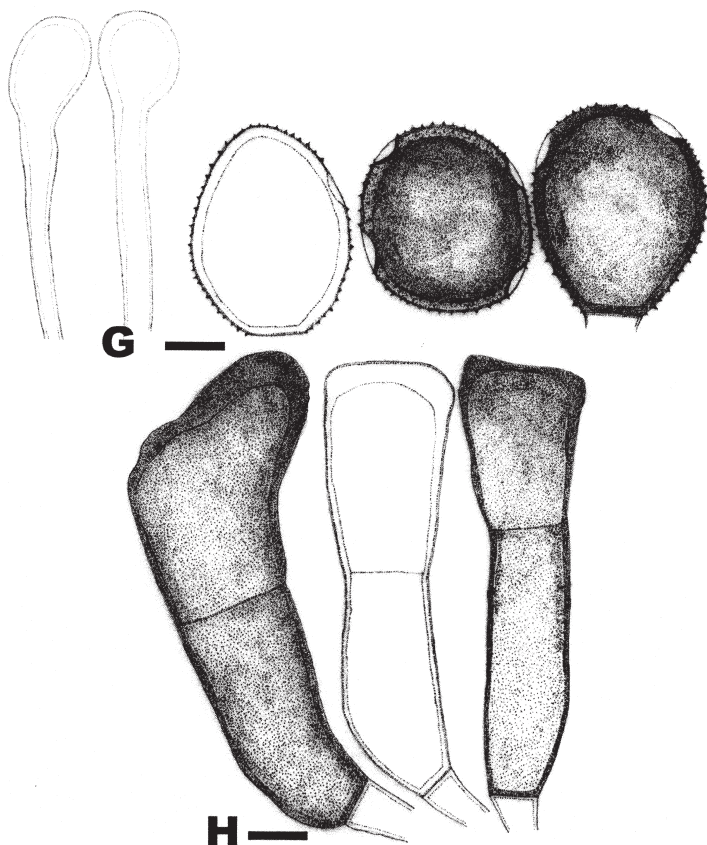
COMMENTS: *Puccinia brachypodii* var. *poae-nemoralis* has been reported on leaves of *Agrostis munroana*, *Poa nemoralis*, *P. pratensis*, and *P. sterilis* from Kaghan Valley, Sharhan, Swat and Azad Jammu & Kashmir (Ahmad et al. 1997).

P. brachypodii var. *poae-nemoralis* is reported for the first time from Fairy Meadows and Hunza, Northern Areas of Pakistan; *Anthoxanthum odoratum* is a new host for rust fungi from Pakistan.

Puccinia poarum P. Nielsen, Bot. Tidsskr., ser. 3, 2: 34 (1877)

FIGS G–H

SPERMOGONIA and AECIA unknown. UREDINIA amphigenous, subepidermal, light yellow to light brown, 0.6–0.8 × 1.9–2.0 mm. UREDINIOSPORES globose to subglobose or obovoid, 20–26 × 23–30 µm (mean 22.92 × 26.71 µm); wall 1.5–2 µm thick, light yellow to pale brown, echinulate; germ pores 4–5(–8), obscure; pedicel hyaline, 5–6 µm wide and ≥ 15 µm long. PARAPHYSES few, clavate to capitate, peripheral, hyaline to pale yellow, head 19–21 µm wide, wall ≥ 2 µm thick, 94–100 µm long. TELIA amphigenous, covered by the epidermis, rarely



FIGS. G–H: *Puccinia poarum*.

G. Urediniospores and paraphyses. H: Teliospores. Scale bars = 10 µm.

loculate, dark brown, $0.4\text{--}0.7 \times 0.6\text{--}0.8$ mm. TELIOSPORES 1–2 celled, oblong to clavate; wall $2\text{--}3$ μm thick, golden brown to chestnut brown but paler basally, smooth; $11\text{--}19(-22) \times 37\text{--}58(-67)$ μm (mean 15.7×47.9 μm); apex truncate or conical to obliquely conical, $3\text{--}5$ μm thick; germ pore 1 per cell, obscure; pedicel short, brown, $6\text{--}7 \times 9\text{--}11$ μm .

MATERIAL EXAMINED: PAKISTAN, NORTHERN AREAS, Fairy Meadows, at 3,036 m a.s.l., stages II + III, on *Poa pratensis* L., 12th August, 2007, NSA # G 371 (LAH NSA1077).

COMMENTS: *Puccinia poarum* has been reported on *Poa annua* from Lahore by Ahmad (1956a,b), on *Agrostis* sp. from Kaghan valley and Azad Jammu & Kashmir by Kakishima et al. (1993b). *Puccinia poarum* is newly recorded from Fairy Meadows, Northern areas of Pakistan.

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